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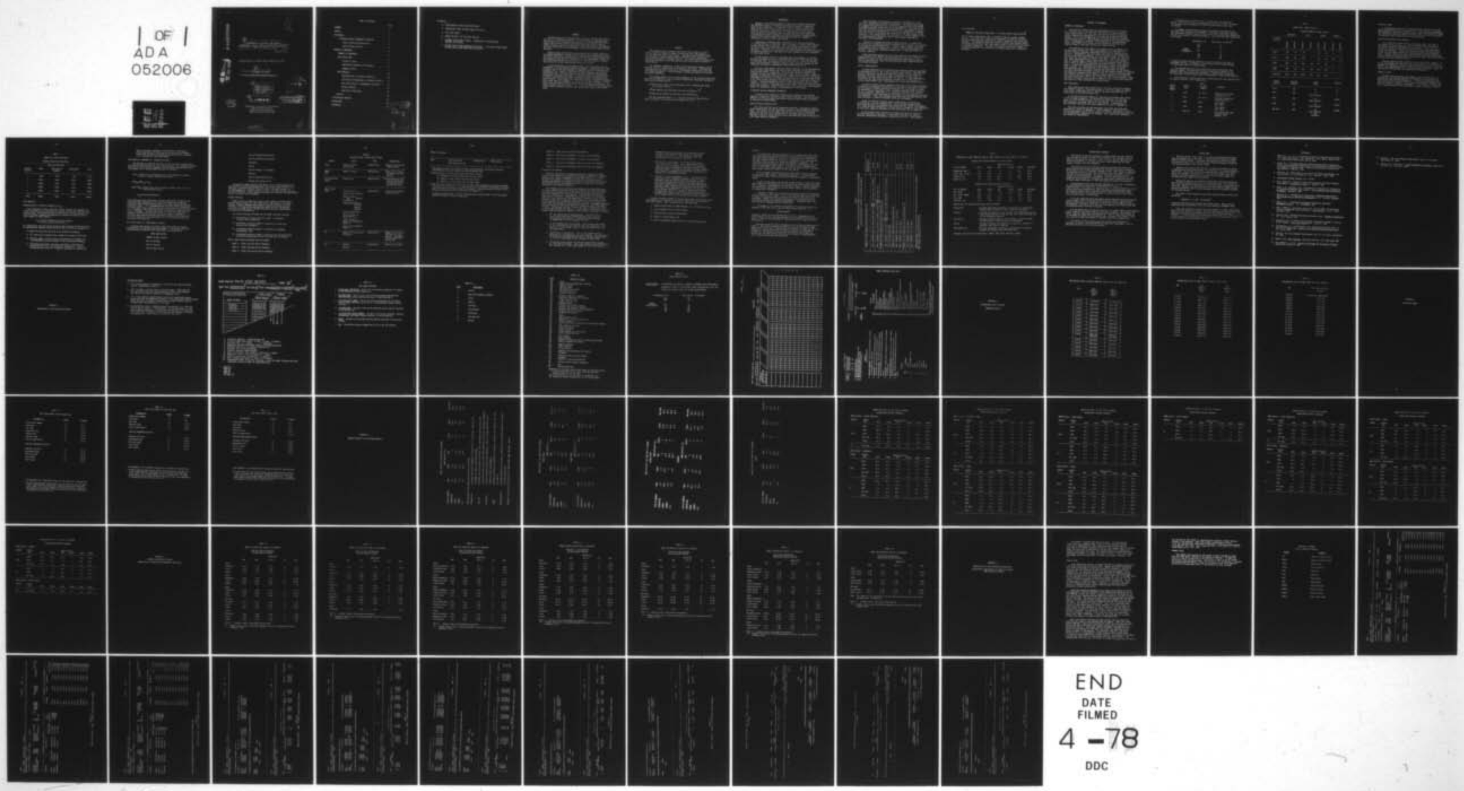

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A METHODOLOGY TO ESTIMATE WORK FORCE REQUIREMENTS IN MILITARY FOOD SERVICE FACILITIES

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Revised Version of Report Dated February 15, 1977

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8 November 1977

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SUMMARY

Determining the work force necessary to run a military food service facility is a complicated problem. It is difficult to determine how many workers of various types are necessary to prepare and serve meals because the required number could depend upon many factors such as number of meals, modes of organization, and worker pacing. Furthermore, the need for workers varies throughout the day typically peaking during mealtime.

Despite these difficulties, the enormous cost of labor argues for a standard methodology to help in the planning and scheduling of workers. This report describes a methodology for determining minimum manpower requirements for each hour of a working day. The methodology is based on over 150,000 work-sampling observations at five dining halls at three facilities (Air Force, Army and Navy were represented).

It was found that the following factors affect the work force requirements to a statistically significant degree: number of meals, type of meals, day of the week (weekday or weekend), duties of food service attendants (i.e., some kp's perform some cook's duties), the activity taking place (eg., serving, clean up) and the duration of the serving, preparation and clean-up periods. A series of models are presented to be used in estimating work force requirements from a knowledge of the above factors. These models are especially accurate in predicting demands during peak hours on weekdays when estimates are most critical. During those times the models explain 72% to 94% of the demand variations. The models, however, may not be valid for facilities which have characteristics significantly different from the four dining halls used in the current study.

PURPOSE

The purpose of the research summarized in this report is to develop a series of models to predict hourly work force requirements in U.S. military food service facilities. The models predict hourly needs for two types of workers whose numbers cannot be easily determined--cooks and food service attendants (kp's). The latter are also categorized according to whether or not they perform activities normally defined as cook's duties.

The estimates produced by a model can be modified by managers should there be special circumstances not included in the model. The resulting estimates are then used as the basis for determining work force size and for scheduling workers. Either computer or manual procedures can be used to prepare schedules.

Since these models are to be used frequently in the field by individuals who will not necessarily have a technical background, they were designed to have certain characteristics:

- (1) They are as simple as possible while still including the effect of all major factors,
- (2) They require only data which are easy to obtain, and
- (3) They do not require a great deal of calculation.

The work reported herein is a revised version of the predictive models presented in the report dated February 15, 1977.

BACKGROUND

Because of the rapid increase in labor costs in both the private and the public sector, effective utilization of workers is becoming more and more important. A pertinent study by Smith [1] shows that labor costs can be as much as 55 percent of the total annual cost of military food service operations. In another study [2], he states that as much as 33 percent of the available labor in these operations is nonproductive due to improper or inefficient worker schedules while Kazarian [3] indicates that the nonproductive labor in commercial restaurants can be as high as 45 percent.

Department of Defense (DOD) expenditures for food services were 1.5 billion dollars in 1974 [4]. Above estimates of excess labor applied to the military sector indicates that, with perfect scheduling, as much as 275 million of the 825 million in labor expenditures might not be necessary. Although it is impossible to avoid nonproductive time completely, it should be quite clear that more efficient schedules are very desirable for the armed forces.

At the current time it is estimated that approximately 1.5 million military personnel are fed in over 2000 food service facilities and that KP contracts total in excess of 100 million dollars. These KP contracts cover civilian workers involved primarily with sanitation aspects of the operations (cleaning, dishwashing, table preparation, etc.).

The first step towards efficient worker schedules is the determination of work force requirements, not only in the aggregate, but by specific time periods within a given day. Food service facilities exhibit very irregular worker requirements which, for rather obvious reasons, cannot be smoothed as completely as might be done in most goods-producing environments. The demand for services are highly variable from day to day and even within a day (from serving period to serving period such as breakfast to lunch to dinner). This same phenomenon occurs in other environments such as banks (tellers), airlines (ticket and reservation clerks) and retail stores (salespeople and cashiers). Predicting work force requirements in an environment where this phenomenon occurs is the objective of this study.

LITERATURE REVIEW--MANPOWER ESTIMATION

A search of the technical literature has revealed only a limited amount of research in the area of work force estimation. The bulk of this research is directed toward the goods-producing organizations as opposed to the service organizations.

Goods-Producing Organizations

Drui [5], with the use of regression equations, attempted to predict worker requirements for the functional areas of a goods-producing organization. The results of this paper indicate that this statistical method applied to the work force distribution of an organization by function, provides a guide to selective work force reduction when used in conjunction with "good business judgement".

Wabel and Bush [6] developed an approach to probabilistic forecasting of engineering personnel requirements. The approach was based on a statistical technique that utilized an expected value calculation to estimate probable future work force requirements in the face of uncertainty about the success of outstanding bids. The number of persons required for each outstanding bid, as well as a probabilistic estimate that the bid will be accepted, was required for the application of the technique. This approach will be valid only if a "large" number of bids are simultaneously outstanding, and if the personnel required are reasonably interchangeable.

Packard [7] extended the works of Wabel and Bush to include the very practical consideration that the probability of success is a function of the age of the outstanding bid. A matrix, whose elements represent the probability that a contract will result in the nth month after submission if the bid was submitted m months ago, is required input for Packard's approach.

Other published methods for work force estimation for goods-producing organizations can be found in the literature [8], [9], [10]. These methods are similar to the techniques previously mentioned and require that the possible work loads can be defined and their probabilities of occurrences estimated.

Service Organizations

A three-staged work force planning and scheduling model was developed by Abernathy, et al. [11] for a service sector organization. The model has specific application in the nurse-staffing process in acute hospitals. Abernathy utilized a Monte Carlo model to determine minimal staff requirements that met specified service risk levels. A linear programming formulation was then used to determine optimum staff allocations to satisfy these minimal staff requirements for a specified staffing policy.

The Public Health Service recognized the need for work force estimation in hospitals and engaged the University of Michigan's Institute of Science and Technology to develop staffing requirements for the laundry, dietary, and pharmaceutical departments [12]. Standard elemental times necessary for the successful completion of all operational activities in each of these departments were developed by the University using Industrial Engineering techniques. These time standards were then used with departmental work load statistics to obtain reasonable staffing requirements.

Smith [2] provides the most recent research work in work force estimation for a service organization. Using the data obtained from a work sampling study, he estimates the minimum periodic worker requirements for a food service organization by multiplying the productive time proportion by the actual number of employees on duty during each day of operation.

At the present time, the basis for authorizing staffing levels of military food service personnel is determined from empirical manning equations developed by Management Engineering (ME) [13]. Each equation

is of the form

$$\text{Number of Personnel Authorized} = A \cdot (\text{Value of Work Load Factors})^{B}$$

and is used in conjunction with a "rounding" table to produce integer results. The values for A and B were determined for both the operating and supervisory personnel equations by linear regression and correlation analysis. The respective work load factors selected were average number of rations served daily (each three meals served is one ration) and number of personnel supervised. The value of the work load factor "number of personnel supervised" is provided by the manning equation for operating personnel.

METHODS OF PROCEDURE

SUMMARY OF PROCEDURES

The empirical manning equations developed by the U.S. Air Force are currently used as the basis for determining the aggregate work force authorizations for a military food service facility. Detailed worker schedules are determined in an ad hoc way by the food service manager. Smith [2] has shown that the resulting staffing and scheduling procedures result in approximately one-third of the available labor spent in nonproductive pursuits. He determines the minimum periodic worker requirements for a given facility through an extensive work sampling study of the labor activities at that facility.

The objective of this report is to develop a set of models which can be used to predict work force requirements for a food service facility without repeatedly performing extensive work sampling on the facility. Consequently, one must obtain data that is representative of military food service operations in a more general sense. At the time this study was initiated, the factors that have a significant effect on work force requirements had not been identified. This study attempts both to identify some of these factors and to incorporate these factors into a series of empirical equations for predicting work force requirements. In order to accomplish these objectives a number of procedures were utilized: (1) The design of a work sampling study to obtain representative data on military food service operations; (2) the design of a data collection procedure to obtain the work sampling data; (3) graphical and analytical analyses of the data in order to identify significant work load factors; and (4) stepwise multiple linear regression to incorporate the significant factors into a set of empirical work force equations. These equations can then be used instead of having to rely on more work sampling. The details of these procedures are covered below.

DATA COLLECTION

Work sampling was used as the basis of the data collection procedure. This method is based on the principle that a sufficient number of samples taken from a large group tends to exhibit the same characteristics of distribution as the entire group [14].

In the data collection phase, all food service personnel were placed in one of seven categories: (1) Dining Hall Supervisor, (2) Military Cook, (3) Civilian Shift Leader, (4) Civilian Cook, (5) Civilian Food Service Worker, (6) Baker, and (7) On Job Trainee. A description of the functional activities for these categories is given in Appendix A.

The work activities for the study were classified into forty-two categories as listed in Appendix A. These categories include all of the ones used by Smith [1,2] in prior studies of military food service facilities so that meaningful comparisons can be made. Also, additional categories were added for completeness.

The work areas were classified as falling into nine functional areas: (1) Office, (2) Meat and Vegetable Cooking, (3) Salad, (4) Bakery, (5) Dishroom, (6) Pot Washing, (7) Storeroom, (8) Serving Line, and (9) Dining.

A category for performance rating was included to provide data on the effort the employees were expending. The analyst (observer) compared the performance (speed or pace) of the food service worker under observation with his own concept of normal performance. The pace factor was categorized as follows:

	Performance (%)	Pace Factor (2 digits)
	120	12
	110	11
NORMAL PERFORMANCE	100	10
	90	09
	80	08
	70	07

It should be noted that the observers were not trained in the area of performance rating. Consequently, this data was not utilized although it might prove useful in future studies.

Five representative military dining halls were selected for work sampling studies. The dining halls were selected with respect to the potential work load factors they possessed. Considerations were given to each branch of the military within the geographic limits of New England.

The dining halls selected and the corresponding work load characteristics are shown in Tables 1 and 2 respectively.

TABLE 1

DINING HALL NUMBER	DINING HALL	MILITARY BRANCH	LOCATION
1	Alert	Air Force	Pease Air Force Base Portsmouth, N.H.
2	Main	Air Force	Pease Air Force Base Portsmouth, N.H.
3	#649	Army	Fort Devens Ayer, Mass.
4	#694	Army	Fort Devens Ayer, Mass.
5	Ney Hall	Navy	Navy Educational and Research Center Newport, R.I.

TABLE 2

DINING HALL CHARACTERISTICS

DINING FACILITY	AVERAGE NUMBER OF MEALS SERVED: BREAKFAST		LUNCH		DINNER		MIDNIGHT	
	WEEKDAYS	WEEKENDS	WEEKDAYS	WEEKENDS	WEEKDAYS	WEEKENDS	WEEKDAYS	WEEKENDS
Alert	50	90	80	---	50	80	---	---
Main	280	190	480	---	380	445	100	80
#649	280	165	450	190	375	200	---	---
#694	225	115	370	160	265	160	---	---
Ney Hall	925	560	1000	670	780	730	---	---

DINING FACILITY	SEATING CAPACITY	SHORT ORDER	BUSSING
Alert	100	NO	KP
Main	350	YES LUNCH WEEKDAYS	KP
#649	300	YES LUNCH WEEKDAYS	PATRON
#694	300	YES LUNCH WEEKDAYS	PATRON
Ney Hall	500	YES LUNCH WEEKDAYS AND WEEKENDS	PATRON

Length of Study

A representative period of time where normal manning existed and which included variations in the work load or work function categories was selected for each work sampling study. Each study covered a fifteen day consecutive period of time with one day being utilized for observer "orientation" and fourteen days for data collection.

Observation Schedule and Procedure

In a dining hall where activity fluctuates widely from hour to hour and/or within an hour, it is desirable that every time period considered has equal representation in the sample. Also, it is desirable to insure that the data collected possess a reasonable degree of relative accuracy. These were attained by scheduling observation rounds for each observer every five minutes during the work sampling hours. During a particular round, each observer would locate the food service workers assigned to him and would record their job classification, location, activity, and pace factor.

The work sampling hours scheduled at each dining hall covered: six of the ten weekdays for the entire period of operation, the other four weekdays for contiguous periods including the serving times for two meals, and all four weekend days for the entire period of operation. Hours of observation by dining hall are summarized in Appendix B.

Summary of Data

The data collection phase represented a total of 2562 hours of observations covering both weekdays and weekends and resulted in the gathering of over 160,000 observations. The data was keypunched onto cards and verified; copies of these cards were submitted to Natick Labs. The card format is presented in Appendix C. The number of observations made at each dining hall for each worker category is shown in Table 3.

TABLE 3

NUMBER OF OBSERVATIONS MADE

DURING DATA COLLECTION PHASE

	JOB CLASSIFICATION			
DINING FACILITY	COOKS	FOOD SERVICE WORKER	SUPERVISOR	TOTAL
1	2432	2794	885	6111
2	11702	9692	3229	24623
3	20836	13940	5131	39907
4	19452	14951	3473	37876
5	15838	36284	5923	58045
TOTAL	70260	77661	18641	166562

DATA ANALYSIS

Determination of Fraction Productive (P_{ijk})

The proportion of time a particular worker category was engaged in a productive capacity was calculated for quarter hour periods from the work sampling data. This proportion was determined by dividing the number of times the worker category was observed in a productive capacity by the total number of times observed.

P_{ijk}=fraction productive, worker category i on day j during quarter hour k

All computations and statistical analyses were performed on the University of Massachusetts Computer System using the SPSS statistical package [15].

It should be noted that for work force estimation purposes:

1) All food service workers were assumed to be equally proficient.

2) Military cooks, civilian cooks, and bakers were assumed to be interchangeable and were grouped in the same worker category.

3) Designated rest break, typically considered a nonproductive worker activity [2], was considered "productive". Since a designated work break is a scheduled nonproductive work period

that is inherent, permanent, and definitely unavoidable, classifying the work activities of the food service workers during this period as nonproductive would result in a reduced (i.e., unrealistic) work requirement.

Calculation of Dependent or Response Variable

The dependent or response variable is that variable in the analysis that measures the objective of the research problem. The response variable selected for this analysis represents the minimum productive work force requirements and is defined quantitatively as follows:

$TEMP_{ijk}$=Theoretical estimated work force requirement for worker class i on day j during quarter hour k

$$TEMP_{ijk}=AMP_{ijk} \bullet P_{ijk}$$

Where AMP_{ijk}=Actual work force on duty of worker class i on day j during quarter hour k

P_{ijk}=fraction productive

Since there were only two workers (one for each shift) in each of the following worker categories, Civilian Shift Leader and Dining Hall Supervisor, work force estimation models for these categories were not considered useful. It is recommended that the work force requirements for these supervisory categories continue to be based on Air Force criteria [13]. Therefore, TEMP values were only calculated for cooks and food service attendants. Average TEMP values for cooks and food service attendants during specified work periods are shown in Appendix D. It should be noted that food service personnel that were performing work activities outside of the Dining Hall and also the cashier, were not included in this analysis.

Work Load Factors or Independent Variables

The work load factors are those factors that might be related quantitatively to the work force requirements. The factors that were considered to be potential work load factors are shown below:

WORK LOAD FACTORS

Number of Meals Served

Day of the Week

Hour of the Day

Type of Meal Served

Type of Preparation Required

Serving and Non-serving Hours

Equipment

Layout

Arrival Pattern of Customers

Bussing

Size of the Dining Facility

Percent Utilization of KP

A predictive model requires that, where at all possible, quantitative relationships be developed between work load factors and work force size. Obtaining a quantitative description of some of the above factors is straightforward--eg., number of meals served. For other factors the task was more difficult. After examining and analyzing the data, the quantitative factors in Table 4 were developed.

Graphic Analysis

When a series of numerical values of the response variable TEMP is plotted against values of a work load factor, the result is a scatter diagram. Scatter diagrams were plotted to provide insight as to the selection of an appropriate mathematical model and the time periods over which it might apply, thereby eliminating obviously unacceptable or implausible relationships.

The scatter diagrams provided the following plausible insights:

1) A multivariate linear regression model is reasonable for work force estimation;

2) A different predictive model is necessary for cooks and food service attendants;

3) A different predictive model is necessary for weekdays and weekends; and,

4) A different predictive model is necessary for serving periods and non-serving periods but not for each hour of the day.

Hence, eight predictive models were developed.

Model 1: Cooks--Serving Period--Weekdays

Model 2: Cooks--Serving Period--Weekends

Model 3: Cooks--Non-serving Period--Weekdays

TABLE 4

CATEGORIZATION OF WORK LOAD FACTORS

FACTOR	UNITS	TYPE	DESCRIPTION
Meals	Number of Meals per hundred	Quantitative	*Meals served during a meal period
HOURS HRS	Number of Hours	Quantitative	**Hours in a serving or between serving period
KP UTILIZATION KPUSE	Percent (%)	Quantitative	***Utilization of food service attendants in preparation and serving functions
MEAL FACTOR MFACT	Serving Period Cook to Order-MFACT=2 Cook to Order and Preprepared -MFACT=3 Preprepared-MFACT=1 (Dinner) MFACT=2 (Lunch) Non-serving Period Prior to Cook to Order-MFACT=1.5 Prior to Cook to Order and Preprepared-MFACT=3 Prior to Preprepared-MFACT=2.5	Quantitative	Type of meal served or to be served
KP	Number of Food Service Attendants	Quantitative	Number of KPs to be utilized in a work period. (Developed from KP models M5, M6, M7, M8
DAY	Weekday Weekend	Qualitative	Period of the week

TABLE 4 continued

TIME	Serving period Off-serving period	Qualitative	Work period

*The number of meals to be used in "non-serving periods" for KPs are from the preceding meal, and for cooks from the subsequent meal.

**Serving hours for meals should be extended to include:

a) BREAKFAST--1/4 hour before and 1/2 hour after

b) LUNCH--1/2 hour before and 1/2 hour after

c) DINNER--1/2 hour before and 1/4 hour after

***The Dining Hall Supervisor must rely on their "best judgement" to obtain estimates for this work load factor. The KP contract and a few direct observations of worker activities should provide reasonable estimates. The KPUSE values utilized in this study were obtained from the data shown in Appendix D.

It should be noted that a factor is categorized as qualitative if its occurrences cannot be placed in order of magnitude.

Model 4: Cooks--Non-serving Period--Weekends

Model 5: Food Service Attendant--Serving Period--Weekdays

Model 6: Food Service Attendant--Serving Period--Weekends

Model 7: Food Service Attendant--Non-serving Period--Weekdays

Model 8: Food Service Attendant--Non-serving Period--Weekends

Statistical Techniques

Multiple regression is a general statistical technique through which one can analyze the relationship between a dependent or response variable and a set of independent or work load factors [17]. Since increasing the number of factors recognized by the model normally improves the measure of correlation, tests of significance to estimate the probability that improvements were due to chance are critically important in multivariate analysis.

An extended version of the Forward Stepwise Inclusion Method was utilized in order to provide insight into the "best" predictive models. The inclusion procedure inserts and removes work load factors in the predictive equation until the equation is considered "satisfactory". The order of insertion is determined by using the partial correlation coefficient as a measure of the importance of factors not yet in the equation. After each regression step, those work load factors already in the equation are re-examined to determine if they still provide a significant contribution to the predictive equation. Judgement regarding the significance of their contribution is based upon their individual F ratios. Any variable with an F ratio less than a prespecified value is considered eligible for removal. As each factor is entered into or removed from the predictive equation, the following values are calculated:

1. R^2, the coefficient of determination. The closer R^2 is to one, the better the fitted predictive model explains the variation in the data. The minimum level specified in AFM25-5[16] for this parameter is 0.50.

2. S, the standard error of estimate. The residual mean square S^2 is an estimate of the variance about the regression. The smaller it is the better, that is, the more precise will be the predictions.

3. Coefficient of Variability. This is the standard error S expressed as a percentage of the mean response. The coefficient of variability provides another way of examining the decrease in S in its relationship to the response variable TEMP.

4. The partial F-test values for the work load factors <u>not yet in</u> the predictive model. These show whether a work load factor will account for a significant amount of variation over that

removed by factors previously in the predictive model. As soon as the partial F value related to the most recently entered fact is considered non-significant no additional factors will be inserted.

5. The partial F-test values for the work load factors "in" the predictive model. These show whether a work load factor still accounts for a significant amount of variation over that removed by the other factors in the predictive model. As soon as the partial F value related to a factor is considered non-significant the factor is removed from the predictive model.

6. "Overall" F test for goodness of fit. The overall F test uses statistical inference procedures to test the null hypothesis that the coefficient of determination (R^2) is zero in the population from which the sample was drawn. Expressed in another way, the test indicates whether the (assumed random) sample of observations being analyzed has been drawn from a population in which R^2 is equal to zero, and any observed R^2 is due to sampling fluctuation or measurement error. It should be noted that the null hypothesis was rejected for all predictive models developed at the .0005 level of significance (see results section).

The best predictive model is the one which best reflects work force requirements as a function of one or more statistically significant work load factors. The criteria used for selection were:

1) Highest Coefficient of Determination, i.e., R^2 closest to one,

2) Least Standard Error of the Estimate,

3) Plausibility of the resulting model,

4) Overall F Significance, and

5) Ease of estimating factor levels for future time periods.

RESULTS

The significant factors determined in the stepwise multiple linear regression procedure described in the last section are incorporated in the seven models summarized in Table 5. Requirements are predicted for the type of worker (cook or food service attendant) for a given period (serving or non-serving) on a given day (weekday or weekend). The particular serving period or non-serving period is incorporated via the factor labeled MFACT (meal factor). The coefficient of determination (R^2) for the models ranges from a low of 72% to a high of 97%; unusually good values resulted for models M1, M5, M6, and M8.

A set of tables summarizing the predicted TEMP values as compared to the actual TEMP values is presented in Appendix E. A statistical validation of these results will be performed and included in a subsequent report.

In each of the models, the overall F-significance is less than 0.0005 which means that the expression for personnel requirements would have less than 5 chances in ten-thousand of occurring by chance. Details regarding the statistical significance of the individual factors and interactions are summarized in Appendix F.

A predictive model for cooks during non-serving periods on weekends is not included in this report. All of the proposed models that have been evaluated to date have failed to meet one or more of the criteria for acceptance. Models with suitable coefficients of determination were too complicated and also lacked reasonableness. Reasonable models had coefficients of determination well below 50%.

An attempt to fit a predictive equation for cooks during lunch on weekdays of the same form as the AIR FORCE manning equation; i.e.,

$$\text{COOKS} = \text{A} \cdot \text{MEALS}^{\text{B}}$$

produced a coefficient of determination of 0.01%. Consequently, predictive models of this form were dropped from consideration since this period is the most well-behaved (or regular) period for cooks across all dining halls.

The worker activity results obtained in this study are summarized in Table 6: the results reported by Smith [2] are also included so that comparisons can be made. Detailed activity reports for cooks and KPs by Dining Hall, period of the day, and day of the week are included in APPENDIX D. The percent of total time classified as non-productive (across the four dining halls studied in this report) is approximately 36%, slightly higher than found by Smith.

TABLE 5

SUMMARY OF REVISED PREDICTIVE MODELS FOR FOOD SERVICE PERSONNEL

REVISED DEFINITION OF FACTORS IS CONTAINED IN TABLE 4

NUMBER OF COOKS DURING SERVING PERIOD MFACT ON:	Coefficient of Determination
(M1) $\text{WEEKDAY}=3.09+.179\cdot\text{MEALS}\cdot\text{MFACT}\cdot\text{HRS}-\text{KP}\cdot\frac{\text{KPUSE}}{100}\cdot(.475\cdot\text{MFACT}\cdot\text{HRS}-.708\cdot\text{MFACT})$	85.14%
*(M2) $\text{WEEKEND}=5.12-1.29\cdot\text{HRS}+1.36\cdot\text{MFACT}-.609\cdot\text{KP}\cdot\frac{\text{KPUSE}}{100}+.168\cdot\text{MEALS}\cdot\text{HRS}$	63.00%
**NUMBER OF COOKS DURING NON-SERVING PERIOD MFACT ON:	
(M3) $\text{WEEKDAY}=-1.15-.640\cdot\text{KP}\cdot\frac{\text{KPUSE}}{100}\cdot\text{MFACT}+1.43\cdot\text{MFACT}\cdot\text{HRS}+\text{MEALS}\cdot(1.33-.416\cdot\text{HRS})$	71.5%
(M4) NO ACCEPTABLE MODEL	
NUMBER OF KPs DURING SERVING PERIOD MFACT ON:	
(M5) $\text{WEEKDAY}=.376+1.30\cdot\text{MEALS}+.081\cdot\text{KPUSE}$	94.41%
*(M6) $\text{WEEKEND}=.909+1.95\cdot\text{MEALS}$	96.08%
***NUMBER OF KPs DURING NON-SERVING PERIOD MFACT ON:	
(M7) $\text{WEEKDAY}=1.70+1.28\cdot\text{MEALS}$	72.36%
*(M8) $\text{WEEKEND}=1.47+1.76\cdot\text{MEALS}$	93.61%

*Model developed for dining facilities that have three meal periods on weekends.
**No "After Dinner" period for cooks.
***No "Before Breakfast" period for KPs.

TABLE 6

COMPARISON OF WORK SAMPLING RESULTS FROM CURRENT STUDY WITH SMITH'S [2] RESULTS

Summary Work Sampling Results Current Study*

	WORK ACTIVITY (%)					
TYPE OF WORKER	PREP.	SERVE	SAN.	SUPPLY	SUPER.	NON-PROD.
SUPERVISOR (MIL.)	5.1	3.5	.9	.9	50.5	39.0
COOKS (MIL. & CIV.)	32.2	16.3	5.7	1.2	5.7	38.8
LEADER (CIV.)	5.3	4.3	21.5	.2	25.9	42.8
FOOD SVC. ATT.	6.5	10.9	48.1	.4	2.3	31.8

Summary Work Sampling Results by Smith

	WORK ACTIVITY (%)					
TYPE OF WORKER	PREP.	SERVE	SAN.	SUPPLY	SUPER.	NON-PROD.
MIL. COOK	0.4	7.7	7.5	17.2	16.6	44.0
CIV. SHIFT LEADER	32.1	11.7	7.5	0	10.0	35.7
CIV. COOK	27.1	29.3	9.3	0.2	1.6	31.3
FOOD SVC. ATT.	6.0	9.0	46.7	0.4	1.0	29.8

Definitions for the work activities are as follows:

Preparation	--includes obtaining ingredients, preparation of ingredients, cooking food, placement of food in serving containers.
Serving	--includes cutting portions on serving line, replenishes serving line, sets up and tears down serving line, makes beverages and refills beverage dispensers.
Sanitation	--includes cleaning utensils and equipment, cleaning kitchen and dining area, cleaning tables and tableware.
Supply	--includes unloading and unpacking of supplies, inventory of supplies, and issue of supplies.
Non-productive	--includes designated rest breaks, walking with no apparent purpose, and absence from the dining hall.

*Results are across five dining halls (MAIN, #649, #694, NEY HALL, ALERT)

DISCUSSION OF RESULTS

The results of the data analyses regarding worker activity confirms the statement by Smith [2] that over one-third of the available labor is spent in non productive pursuits. This, in turn, supports the need for reliable procedures to estimate work force requirements and for techniques to obtain efficient schedules.

The results of most of the data analyses regarding the predictive models were unusually good as measured by standard statistical yardsticks. In particular, all of the models included in this report appear to describe the observed activities very well and should prove very useful in predicting work force requirements. Of course, the models should be used in conjunction with management's judgement. Like any quantitative tool, the models do not consider all contingencies and planners should not hesitate to modify model predictions if they can state good reasons for doing so.

Satisfactory results have not been obtained for one model (prediction of cook requirements during non serving periods on weekends). Since the models developed were unsatisfactory for either reasonabless or percent of variation accounted for, they have been omitted from this report. We therefore suggest that schedulers should simply estimate the demand for cooks during the non serving periods on weekends using current methods until suitable models are developed.

It is not surprising that the models did not describe activities during slack periods as well as during periods of peak activity. During slower periods workers had more flexibility in what they did and when they did it. Consequently, patterns of work were not as pronounced as at other times and are therefore more difficult to discern.

All the models must be used with caution in a setting whose characteristics differ markedly from those where the data were collected. For example, the models might not apply where convenience (or "quick") meals were served or if the number of meals was much greater (eg., one and a half times) or much less (one half) than the largest or smallest facilities, respectively.

The results of the current study also provide the information necessary to design a more comprehensive statistical experiment. This is described briefly in the following section.

FUTURE WORK

The most obvious "next step" is to test the methodology developed. This is underway and is described in "Modification of Contract" number DAAG17-75-C-0017-P00004. The models developed could also be improved by collecting data at more facilities which differ markedly in some way from those included in the current study.

Based on the data already obtained, it would be possible to design a comprehensive experimental design to collect data at a larger number of facilities. The current data collection procedures sought all the data which were thought to be important. There is now evidence that some factors which were thought to be important were not while others not included possible might affect workloads.

Because of what has been learned, future data collection would not have to be as extensive as it was in the current study. As a matter of fact, even the current study did not require the volume of data which were collected. However, the Natick Research and Development Command needed the more exhaustive data for other purposes and so we naturally analyzed all the data we had.

Data from a larger number of facilities could be used to refine the expression

$$\text{Manpower} = A \times (\text{No. of Rations})^{B}$$

currently used to help set overall work force levels. More accurate guidelines have the potential to save large amounts of manpower costs.

Since the prediction of work force requirements is such a challenging topic, we will continue to analyze the data collected for the current study both on our own and in conjunction with the implementation project in progress. If improvements are developed for either the seven models presented in this report or the unsatisfactory model, we will forward them to the Natick Research and Development Command.

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APPENDIX A

REPRESENTATIVE DATA COLLECTION PACKET

Instruction Sheet

1. Fill in the necessary information at the top of the data collection form as illustrated in Table A-1.

2. Fill in column 1 (time of day) of the data sheet. Begin with the hour (military time) the study commences on line 1, and increase the time in five minute intervals on subsequent lines.

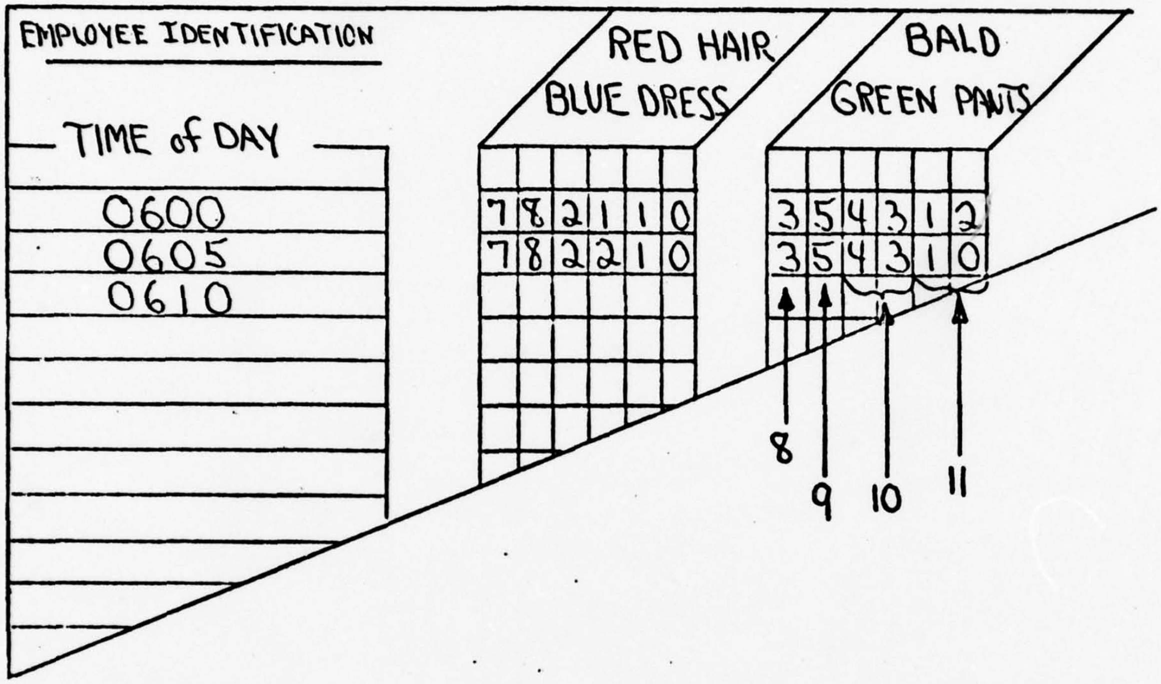
3. Fill in the employee identification sections for each food service worker that you are scheduled to observe. This descriptive identification should be explicit enough to enable you to quickly "locate" the individual when an observation is to be made.

4. An observation round is scheduled every five minutes (i.e., when the time of day in column 1 is encountered). During that time, all food service workers that you are required to observe must be located and their activities recorded in the appropriate data columns of the data collection form. (See Tables A-1, A-2, A-3, A-4, A-5)

TABLE A-1

WORK SAMPLING STUDY FOR FORT DEVENS CODE 3 [1]

DATE CODE 070776 [2] DAY CODE 4 [3] TIME: FROM 0600 TO 0655 [4] OBSERVER CODE 01 [5]



1. Cafeteria code*(e.g., #649=Cafeteria #3)
2. Six digit date code (month - 2, day - 2, year - 2 digits)
3. Day code (e.g., 1 = Sunday, ...7 = Saturday)
4. Beginning and ending military times of the sampling period
5. Observer code (e.g., M. Spratt = Observer #1)
6. Military time of the observation
7. Specific employee identification
8. Job classification code (refer to Table A-2, 1 digit)
9. Department code (refer to Table A-3, 1 digit)
10. Activity code (refer to Table A-4, 2 digits)
11. Pace rating factor (refer to Table A-5, 2 digits)
12. Preparation factor (0-prep for next meal, 1-prep for meals following the next scheduled, 2-prep for meals on subsequent days

*ALERT #1
MAIN #2
#649 #3
#694 #4
NEY HALL #5

TABLE A-2

JOB CLASSIFICATIONS

1. DINING HALL SUPERVISOR: The E-7 or E-6 military supervisor in charge of the operation of the dining hall.

2. MILITARY COOK: The E-4, E-3, or E-2 military person who performs administrative and/or cooking functions in the dining hall.

3. CIVILIAN SHIFT LEADER: The WL-8 civilian responsible for assigning work to other civilians on his shift, or who performs actual cooking function.

4. CIVILIAN COOK: The WG-8 civilian who performs actual cooking functions in the dining hall.

5. CIVILIAN FOOD SERVICE WORKER: The WG-2 civilian who performs cleaning, dishwashing, and other related functions in the dining hall.

6. BAKER: The WG-8 civilian who performs baking functions in the pastry kitchen.

7. OJT: The military person categorized as an on the job trainee.

TABLE A-3

Code	Department
1	Office
2	Meat and vegetable cooking
3	Salad
4	Bakery
5	Dishroom
6	Pot washing
7	Storeroom
8	Serving line
9	Dining

TABLE A-4

Code	Activity Listing
01	Idle
02	Absent from assigned work station
03	Walking loaded
04	Walking empty
05	Designated rest break
06	Miscellaneous work
07	Personal hygiene
10	*Prepares meats for cooking
11	*Prepares vegetables for cooking
12	Cooks food off line
13	Cooks food on line
14	*Prepares soups
15	*Prepare and assemble salads
16	*Prepare and assemble desserts
17	*Prepare and assemble cold sandwiches
18	Prepares cooking utensils
19	*Prepares for baking
20	Bakes
21	Set up serving line
22	Replenish or close serving line
23	Serves customers
24	Serving--being at attention to the serving process
31	Wash utensils and pots
32	Cleans equipment
33	Cleans kitchen
34	Cleans dining area and tables
35	Clean dishwashing area
41	Clear tables
42	Set up tables
43	Operates dishwasher--wash silverware and dishes
44	Stack silverware and dishes
51	Receive supplies
52	Order supplies
53	Issue supplies
61	Prepares correspondence and records
62	Telephone
71	Monitors report and OJT program
72	Inspects
73	Receives or gives supervision
83	Collect cash & conduct headcount
91	OJT
92	Maintenance/repair

*Indicate in the blank space to the right of the data column
√--if the preparation is for meals following the next scheduled meal on the same day
X--if the preparation is for meals on subsequent days
NO indication implies preparation is for the next meal

TABLE A-5

PACE RATING FACTOR

PACE RATING - A technique by which an analyst compares the performance (speed or pace) of the worker under observation with the observer's own concept of normal performance.

	Performance (%)	Pace Factor (2 digits)
	120	12
	110	11
NORMAL PERFORMANCE	100	10
	90	09
	80	08
	70	07

SAMPLE DATA COLLECTION FORM

Sheet____ of____

Work Sampling Study for ______________________________ Code ☐

Date Code ☐☐☐☐☐☐ Day Code ☐ Time: From ☐☐☐☐ To ☐☐☐☐ Obser. Code ☐☐

Employee Identification / Time of Day						

SAMPLE OBSERVER WORK SHEET

BROWN FANIS/7

0600	3	5	4	3	0	9
6	8	9	10		11	

6. Military time of the observation
7. Specific employee identification
8. Job classification code (refer to Appendix B, 1 digit)
9. Department code (refer to Appendix C, 1 digit)
10. Activity code (refer to Appendix D, 2 digits)
11. Pace rating factor (2 digits) Appendix E

Appendix B
JOB CLASSIFICATIONS

1. DINING HALL SUPERVISOR: The E-7 or E-6 military supervisor in charge of the operation of the dining hall.
2. MILITARY COOK: The E-4, E-3, or E-2 military person who performs administrative and/or cooking functions in the dining hall.
3. CIVILIAN SHIFT LEADER: The WL-8 civilian responsible for assigning work to other civilians on his shift, or who performs actual cooking function.
4. CIVILIAN COOK: The WG-8 civilian who performs actual cooking functions in the dining hall.
5. CIVILIAN FOOD SERVICE WORKER: The WG-2 civilian who performs cleaning, dishwashing, and other related functions in the dining hall.
6. BAKER: THE WG-8 civilian who performs baking functions in the pastry kitchen.

APPENDIX C

Code	Department
1	Office
2	Meat and vegetable cooking
3	Salad
4	Bakery
5	Dishroom
6	Pot washing
7	Storeroom
8	Serving line
9	Dining

PACE RATING FACTOR

PACE RATING - A technique by which an analyst compares the performance (speed or pace) of the worker under observation with the observer's own concept of normal performance.

	Performance (%)	Pace Factor (2 digits)
	120	12
	110	11
NORMAL PERFORMANCE	100	10
	90	09
	80	08
	70	07

APPENDIX D

Code	Activity Listing
01	Idle
02	Absent from assigned work station
03	Walking loaded
04	Walking empty
05	Designated rest break
06	Miscellaneous work
07	Personal hygiene
10	*Prepares meats for cooking
11	*Prepares vegetables for cooking
12	Cooks food off line
13	Cooks food on line
14	*Prepares soups
15	*Prepare and assemble salads
16	*Prepare and assemble desserts
17	*Prepare and assemble cold sandwiches
18	Prepares cooking utensils
19	*Prepares for baking
20	Bakes
21	Set up serving line
22	Replenish or close serving line
23	Serves customers
24	Serving--being at attention to the serving process
31	Wash utensils and pots
32	Cleans equipment
33	Cleans kitchen
34	Cleans dining area and tables
35	Clean dish washing area
41	Clear tables
42	Set up tables
43	Operates dishwasher--wash silverware and dishes
44	Stack silverware and dishes
51	Receive supplies
52	Order supplies
53	Issue supplies
61	Prepares correspondence and records
62	Telephone
71	Monitors report and OJT program
72	Inspects
73	Receives or gives supervision
83	Collect cash & conduct headcount
91	OJT
92	Maintenance/repair

*Indicate in the blank space to the right of the data column
✓--if the preparation is for meals following the next scheduled meal on the same day
X--if preparation is for meals on subsequent days

APPENDIX B

OBSERVATION TIMES FOR WORK SAMPLING STUDIES

TABLE B-1

OBSERVATION TIMES FOR WORK SAMPLING STUDY--PEASE AIR FORCE BASE

Day	Work Sampling Hours (Main)	Work Sampling Hours (Alert)
1/16/76	Orientation	Orientation
1/17/76	0500-1300	0700-1500
1/18/76	1100-1900	1100-1900
1/19/76	1100-1900	0600-1900
1/20/76	0400-0300	0600-1400
1/21/76	0500-0300	0600-1900
1/22/76	0400-0200	0600-1400
1/23/76	0500-1300	0600-1400
1/24/76	0400-0200	0600-1900
1/25/76	0500-1100 2300-0100	0700-1200 1500-1800
1/26/76	0400-0200	0600-1900
1/27/76	0400-0300	1100-1900
1/28/76	1100-1900	0600-1900
1/29/76	0400-0200	0600-1900
1/30/76	1100-1900	1100-1900

TABLE B-2

OBSERVATION TIMES FOR WORK SAMPLING STUDY--FORT DEVENS

Day	Work Sampling Hours #649	Work Sampling Hours #694
7/ 6/76	Orientation	Orientation
7/ 7/76	0800-2000	0300-2000
7/ 8/76	0300-2000	0400-1600
7/ 9/76	0400-1600	0300-2000
7/10/76	0700-1830	0700-1830
7/11/76	0700-1830	0700-1830
7/12/76	0300-2000	0300-2000
7/13/76	0300-2000	0800-2000
7/14/76	0300-1500	0300-2000
7/15/76	0300-2000	0800-2000
7/16/76	0300-2000	0300-2000
7/17/76	0700-1830	0700-1830
7/18/76	0700-1830	0700-1830
7/19/76	0400-1600	0300-2000
7/20/70	0300-2000	0400-1600

TABLE B-3

OBSERVATION TIMES FOR WORK SAMPLING STUDY--NEWPORT

Day	Work Sampling Hours Ney Hall
7/26/76	Orientation (0800-1000)
7/26/76	1030-1830
7/27/76	0430-1930
7/28/76	0430-1930
7/29/76	0600-1400
7/30/76	0430-1930
7/31/76	0700-1930
8/ 1/76	0700-1930
8/ 2/76	0430-1930
8/ 3/76	0600-1400
8/ 4/76	0430-1930
8/ 5/76	0430-1930
8/ 6/76	1030-1830
8/ 7/76	0700-1930
8/ 8/76	0700-1930

APPENDIX C

DATA CARD FORMAT

TABLE C-1

DATA CARD FORMAT FOR MAIN AND ALERT

INFORMATION*	FORMAT	COLUMNS
Dining Hall Number	I2	1-2
Date Code	I6	4-9
Day Code	I1	11-11
Beginning Time	I4	13-16
Ending Time	I4	18-21
Observer Code	I2	23-24
Time of Observation	I4	26-29
EMPLOYEE OBSERVATION DATA**		
Employee Job Class	I1	31-31
Department Code	I1	32-32
Activity Code	I2	33-34
Pace Factor	I2	35-36
Prep Factor	I1	37-37

*See Appendix A for complete definitions and numerical designations.

**If more than one food service worker was observed at the same time (time of observation), additional employee observation data (job class, dept., etc.) would appear on the same data card. The data would have the same format indicated above with job class beginning in column 39, 47, 55, 63 or 71.

TABLE C-2

DATA CARD FORMAT FOR #649 AND #694

INFORMATION*	FORMAT	COLUMNS
Dining Hall Number	I2	1-2
Date Code	I6	4-9
Day Code	I1	11-11
Observer Code	I2	13-14
Time of Observation	I4	16-19
EMPLOYEE OBSERVATION DATA**		
Employee Job Class	I1	21-21
Department Code	I1	22-22
Activity Code	I2	23-24
Pace Factor	I2	25-26
Prep Factor	I1	27-27

*See Appendix A for complete definitions and numerical designations.

**If more than one food service worker was observed at the same time (time of observation), additional employee observation data (job class, Dept., etc.) would appear on the same data card. The data would have the same format indicated above with job class beginning in column 28, 35, 42, 49, 56, 63, or 70.

TABLE C-3

DATA CARD FORMAT FOR NEY HALL

INFORMATION*	FORMAT	COLUMNS
Dining Hall Number	I2	1-2
Date Code	I6	3-8
Day Code	I1	9-9
Observer Code	I2	10-11
Time of Observation	I4	13-16
EMPLOYEE OBSERVATION DATA**		
Employee Job Class	I1	18-18
Department Code	I1	19-19
Activity Code	I2	20-21
Pace Factor	I2	22-23
Prep Factor	I1	24-24

*See Appendix A for complete definitions and numerical designations.

**If more than one food service worker was observed at the same time (time of observation), additional employee observation data (job class, Dept., etc.) would appear on the same data card. The data would have the same format indicated above with job class beginning in column 25, 32, 39, 46, 53, 60, 67, or 74.

APPENDIX D

WORKER ACTIVITY (%) FOR COOKS AND KPS

WORK ACTIVITY (%) FOR TYPE OF WORKER

	WORK ACTIVITY (%)					
TYPE OF WORKER	PREP.	SERVE	SAN.	SUPPLY	SUPER	NON PROD.
SUPERVISOR	5.1	3.5	.9	.9	50.5	39.0
COOKS	32.2	16.3	5.7	1.2	5.7	38.8
LEADER	5.3	4.3	21.5	.2	25.9	42.8
KP	6.5	10.9	48.1	.4	2.3	31.8

Definitions for the work activities are as follows:

Preparation --includes obtaining ingredients, preparation of ingredients, cooking food, placement of food in serving containers.

Serving --includes cutting portions on serving line, replenishes serving line, sets up and tears down serving line, makes beverages and refills beverage dispensers.

Sanitation --includes cleaning utensils and equipment, cleaning kitchen and dining area, cleaning tables and tableware.

Supply --includes unloading and unpacking of supplies, inventory of supplies, and issue of supplies.

Non-productive --includes designated rest breaks, walking with no apparent purpose, and absence from the dining hall.

*Results are across five dining halls (MAIN, #649, #694, NEY HALL, ALERT)

WORK ACTIVITY (%) FOR TYPE OF WORKER

PEASE MAIN

			WORK ACTIVITY (%)			
TYPE OF WORKER	PREP.	SERVE	SAN.	SUPPLY	SUPER.	NON PROD.
SUPERVISOR	4.9	3.8	.9	3.2	35.1	52.2
COOKS	26.9	18.9	4.2	1.5	7.7	40.8
LEADER	3.7	4.4	12.7	1.3	26.1	51.8
K.P.	7.0	8.8	52.3	.2	.9	30.8

DEVENS #649

			WORK ACTIVITY (%)			
TYPE OF WORKER	PREP.	SERVE	SAN.	SUPPLY	SUPER.	NON PROD.
SUPERVISOR	7.0	4.1	1.1	.4	44.0	43.4
COOKS	31.2	19.2	5.8	1.0	4.4	38.4
LEADER	6.2	.9	34.1	0	19.4	39.4
K.P.	2.7	.9	63.3	.9	1.0	31.2

WORK ACTIVITY (%) FOR TYPE OF WORKER

DEVENS #694

TYPE OF WORKER	WORK ACTIVITY (%)					
	PREP.	SERVE	SAN.	SUPPLY	SUPER.	NON PROD.
SUPERVISOR	5.5	1.9	.5	.1	67.8	24.2
COOKS	24.8	19.6	5.8	1.6	7.3	41.0
LEADER	3.4	.7	35.4	0	11.0	49.5
K.P.	4.3	1.9	52.0	.7	5.2	35.9

NEWPORT

TYPE OF WORKER	WORK ACTIVITY (%)					
	PREP.	SERVE	SAN.	SUPPLY	SUPER.	NON PROD.
SUPERVISOR	2.6	.9	.3	.2	61.1	35.0
COOKS	47.1	3.4	6.8	.5	3.6	38.6
LEADER	7.1	8.0	2.9	.2	42.5	39.3
K.P.	8.4	19.7	38.5	.1	2.0	31.3

WORK ACTIVITY (%) FOR TYPE OF WORKER

ALERT

TYPE OF WORKER	PREP.	SERVE	SAN.	SUPPLY	SUPER	NON PROD.
SUPERVISOR	9.3	22.4	4.0	.3	54.3	9.8
COOKS	39.3	26.9	5.5	1.7	8.1	18.4
LEADER	.7	9.6	54.8	.7	5.0	29.2
KP	12.1	8.3	56.5	0	1.1	22.0

WORKER ACTIVITY (%) FOR TYPE OF WORKER
DURING WORK PERIODS--WEEKDAYS

WORK PERIOD: BEFORE BREAKFAST

WORKER	DINING HALL	WORK ACTIVITY PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
COOK	MAIN	10.5	6.3	4.2	0	0	78.9
	#649	58.4	9.4	3.7	0	.2	28.3
	#694	23.0	28.2	5.0	1.1	15.2	27.4
	NEY HALL	60.3	6.8	3.4	.9	3.8	24.8
	ALERT	72.0	8.6	4.3	0	8.6	6.5
KP	NEY HALL	8.4	27.1	5.6	1.1	3.3	54.4

WORK PERIOD: BREAKFAST

WORKER	DINING HALL	WORKER ACTIVITY PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
COOK	MAIN	40.5	10.3	3.0	2.6	11.6	32.0
	#649	42.4	22.8	3.4	.2	2.3	29.0
	#694	28.5	23.7	3.6	.9	5.2	38.1
	NEY HALL	55.9	5.9	4.3	.3	3.1	30.5
	ALERT	38.6	33.9	2.2	2.8	5.8	16.8
KP	MAIN	12.6	12.3	47.1	.3	.8	26.9
	#649	.6	.6	72.3	1.0	.6	24.9
	#694	1.3	2.4	56.4	.9	2.2	36.8
	NEY HALL	6.5	31.5	39.1	0	1.2	21.5
	ALERT	0	8.3	65.4	0	0	26.3

WORKER ACTIVITY (%) FOR TYPE OF WORKER
DURING WORK PERIODS--WEEKDAYS

WORK PERIOD: BREAKFAST-LUNCH

WORKER	DINING HALL	WORK ACTIVITY PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
COOK	MAIN	21.4	3.5	10.2	1.7	8.8	54.4
	#649	36.5	9.7	8.6	1.6	5.0	38.6
	#694	40.3	3.2	7.5	4.0	9.0	36.0
	NEY HALL	47.9	1.3	3.2	.4	3.1	44.1
	ALERT	56.1	2.9	3.9	3.9	6.7	24.6
KP	MAIN	3.4	2.0	63.0	.4	1.5	29.8
	#649	.3	1.1	68.2	3.5	.4	26.6
	#694	1.6	3.1	50.9	1.6	12.3	30.5
	NEY HALL	12.0	6.5	36.4	.2	2.9	42.0
	ALERT	10.3	3.8	49.5	0	1.9	34.5

WORK PERIOD: LUNCH

WORKER	DINING HALL	WORK ACTIVITY PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
COOK	MAIN	21.8	29.9	3.4	1.9	8.0	35.0
	#649	28.0	21.7	5.1	1.6	3.9	39.8
	#694	15.4	27.3	5.6	2.1	6.7	42.9
	NEY HALL	43.6	2.3	12.1	.6	4.6	36.8
	ALERT	29.0	39.7	5.6	.3	9.7	15.7
KP	MAIN	7.2	12.1	51.5	.1	.7	28.3
	#649	.7	.9	64.6	.9	1.3	31.5
	#694	1.9	2.3	51.3	1.1	7.8	35.7
	NEY HALL	5.4	33.7	32.6	.1	2.3	25.9
	ALERT	15.6	7.4	53.9	0	1.3	21.8

WORKER ACTIVITY (%) FOR TYPE OF WORKERS
DURING WORK PERIODS--WEEKDAYS

WORK PERIOD: LUNCH-DINNER

WORKER	DINING HALL	PREP	SERVE	WORK ACTIVITY SAN	SUPPLY	SUPER	NPROD
	MAIN	23.7	13.2	5.6	.9	8.8	47.8
	#649	30.7	8.4	4.3	1.6	7.6	47.4
COOK	#694	34.4	3.8	5.3	1.2	8.1	47.3
	NEY HALL	45.3	1.9	5.1	.9	3.2	43.6
	ALERT	36.8	6.8	7.1	1.1	8.3	39.8
	MAIN	16.3	4.4	48.6	0	1.5	29.3
	#649	12.2	1.0	47.3	.4	2.1	37.1
KP	#694	19.4	1.2	40.4	.1	7.5	31.4
	NEY HALL	15.2	3.5	44.9	.1	2.2	34.0
	ALERT	7.5	0	55.1	0	0	37.4

WORK PERIOD: DINNER

WORKER	DINING HALL	PREP	SERVE	WORK ACTIVITY SAN	SUPPLY	SUPER	NPROD
	MAIN	19.2	25.2	3.1	0	6.1	46.3
	#649	6.3	33.7	8.7	.7	4.5	46.2
COOK	#694	7.5	30.2	11.0	.2	5.2	45.9
	NEY HALL	39.6	5.8	9.8	.3	4.6	40.1
	ALERT	9.4	61.2	15.3	0	3.5	10.6
	MAIN	5.5	13.0	46.8	0	.9	34.0
	#649	4.1	1.7	66.5	0	.8	26.8
KP	#694	2.6	1.6	50.7	0	.1	44.9
	NEY HALL	5.4	33.7	34.1	.1	1.5	25.1
	ALERT	3.1	19.1	68.0	0	0	9.8

WORKER ACTIVITY (%) FOR TYPE OF WORKER

DURING WORK PERIODS--WEEKDAYS

WORK PERIOD: AFTER DINNER

WORKER	DINING HALL	WORK ACTIVITY PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
KP	MAIN	2.0	4.5	59.8	.5	.2	33.0
	#649	0	1.3	84.4	0	.3	14.0
	#694	0	0	87.9	0	.4	11.7
	NEY HALL	.8	3.7	79.7	.2	1.0	14.7

WORKER ACTIVITY (%) FOR TYPE OF WORKER
DURING WORK PERIODS--WEEKENDS

WORK PERIOD: BEFORE BREAKFAST

WORKER	DINING HALL	PREP	SERVE	WORK ACTIVITY SAN	SUPPLY	SUPER	NPROD
COOK	MAIN	7.0	9.3	2.3	0	11.6	69.8
	#649	38.6	27.6	.7	.7	8.3	24.1
	#694	25.6	33.6	.8	0	13.6	26.4
	NEY HALL	52.1	10.3	.9	1.9	1.4	33.3
KP	NEY HALL	11.4	13.2	4.7	.2	3.3	67.1

WORK PERIOD: BREAKFAST

WORKER	DINING HALL	PREP	SERVE	WORKER ACTIVITY SAN	SUPPLY	SUPER	NPROD
COOK	MAIN	39.6	9.0	3.0	.8	2.4	45.1
	#649	46.1	19.7	4.7	0	2.7	26.7
	#694	39.9	16.7	2.6	.9	9.9	30.0
	NEY HALL	56.5	5.4	1.8	.3	1.6	34.4
	ALERT	45.4	45.9	.5	2.1	4.6	1.5
KP	MAIN	6.2	2.9	49.4	.9	.9	39.8
	#649	.2	.2	57.8	1.2	0	40.5
	#694	0	2.2	52.8	1.4	1.2	42.4
	NEY HALL	12.6	17.6	28.2	0	1.5	40.0
	ALERT	22.7	12.1	47.8	0	1.0	16.4

WORKER ACTIVITY (%) FOR TYPE OF WORKER

DURING WORK PERIODS--WEEKENDS

WORK PERIOD: LUNCH

WORKER	DINING HALL	WORK ACTIVITY PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
COOK	MAIN	15.9	35.4	3.4	.8	2.9	41.6
	#649	34.6	26.4	7.3	.1	3.2	28.2
	#694	21.1	25.3	4.2	.8	4.2	44.5
	NEY HALL	56.8	4.9	2.9	.4	1.2	33.8
KP	MAIN	6.0	6.4	51.0	.1	1.4	35.1
	#649	.1	.6	60.2	.6	.1	38.3
	#694	0	1.7	61.3	.4	2.0	34.6
	NEY HALL	4.8	23.5	31.6	.1	1.7	38.3

WORK PERIOD: LUNCH-DINNER

WORKER	DINING HALL	WORK ACTIVITY PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
COOK	MAIN	15.9	2.3	6.8	0	6.8	68.2
	#649	25.1	7.0	8.8	0	4.4	54.7
	#694	33.8	10.9	4.3	0	1.5	49.5
	NEY HALL	40.6	1.1	3.5	.1	3.1	51.4
KP	MAIN	0	5.5	60.2	0	0	34.4
	#649	0	0	59.7	0	.3	40.0
	#694	0	.3	51.5	0	.5	47.7
	NEY HALL	10.8	3.6	50.2	.2	1.9	33.5

WORKER ACTIVITY (%) FOR TYPE OF WORKER

DURING WORK PERIODS--WEEKENDS

WORK PERIOD: DINNER

WORKER	DINING HALL	WORK ACTIVITY					
		PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
COOK	#649	10.7	25.3	11.4	0	3.0	49.6
	#694	10.9	27.7	3.7	.4	39.0	48.4
	NEY HALL	41.9	1.4	19.4	.5	2.3	34.7
KP	#649	0	.2	57.3	0	1.4	41.2
	#694	0	2.1	54.1	.7	1.2	41.9
	NEY HALL	2.9	32.8	38.6	.1	1.5	24.2

WORK PERIOD: AFTER DINNER

WORKER	DINING HALL	PREP	SERVE	SAN	SUPPLY	SUPER	NPROD
KP	NEY HALL	.2	2.3	78.8	0	1.3	17.3

APPENDIX E

INTERNAL VALIDATION OF MODEL:

COMPARISON OF PREDICTED AND OBSERVED TEMP VALUES

TABLE E-1

MODEL M1 PREDICTIVE RESULTS VS OBSERVED

TEMP FOR COOKS ON WEEKDAYS
DURING SERVING PERIODS

			PREDICTED*		
	MIN	AVG	NO R.T.	R.T.	MAX
MAIN:					
Breakfast	4.56	5.03	3.56	4	5.37
Lunch	5.38	6.23	7.36	7	6.82
Dinner	3.32	3.73	4.12	4	4.35
#649:					
Breakfast	5.40	7.99	7.13	7	10.69
Lunch	9.09	11.83	11.43	11	14.49
Dinner	4.42	6.28	4.76	5	7.79
#694:					
Breakfast	6.16	7.03	7.15	7	8.29
Lunch	9.36	11.80	12.45	12	14.18
Dinner	4.67	5.83	4.94	5	7.64
NEY HALL:					
Breakfast	4.71	6.20	6.70	7	7.00
Lunch	5.73	9.07	8.78	9	11.77
Dinner	2.44	3.85	4.36	5	5.83
ALERT:					
Breakfast	1.86	2.48	3.46	4	2.90
Lunch	1.80	2.68	3.21	3	3.00
Dinner	1.00	1.27	3.09	3	1.74

*NO R.T.: decimal result from predictive equation

RT: integer result using "Fractional Manpower Cutoffs for Computing Military Standards" [16]

TABLE E-2

MODEL M2 PREDICTIVE RESULTS VS OBSERVED

TEMP FOR COOKS ON WEEKENDS
DURING SERVING PERIODS

	MIN	AVG	PREDICTED* NO R.T.	R.T.	MAX
MAIN:					
Breakfast	3.00	3.19	2.44	3	3.50
#649:					
Breakfast	4.42	5.00	5.07	5	5.39
Lunch	3.67	4.60	4.94	5	5.08
Dinner	3.63	4.38	4.37	5	5.03
#694:					
Breakfast	4.97	5.39	5.11	5	5.79
Lunch	4.75	5.13	5.14	5	5.36
Dinner	3.37	4.56	4.47	5	5.44
NEY HALL:					
Breakfast	3.73	4.34	4.45	5	4.80
Lunch	5.26	5.88	5.90	6	6.81
Dinner	2.53	2.77	2.69	3	2.89
ALERT:					
Breakfast	1.0	1.43	1.93	2	1.88

*NO R.T.: decimal result from predictive equation

RT: integer results using "Fractional Manpower Cutoffs for Computing Military Standards" [16]

TABLE E-3

MODEL M3 PREDICTED RESULTS VS OBSERVED

TEMP FOR COOKS ON WEEKDAYS
DURING NON-SERVING PERIODS

	MIN	AVG	PREDICTED* NO R.T.	R.T.	MAX
MAIN:					
Before Breakfast	1.67	2.63	3.73	4	4.00
Breakfast-Lunch	4.38	5.26	8.13	8	5.58
Lunch-Dinner	3.51	4.10	4.37	5	4.74
#649:					
Before Breakfast	3.58	4.85	3.82	4	6.67
Breakfast-Lunch	6.38	9.60	9.02	9	12.57
Lunch-Dinner	7.23	8.87	7.58	8	10.91
#694:					
Before Breakfast	3.80	4.84	4.50	5	5.73
Breakfast-Lunch	6.33	8.94	8.89	9	11.71
Lunch-Dinner	4.61	7.85	6.73	7	11.18
NEY HALL:					
Before Breakfast	4.83	6.83	7.93	8	7.83
Breakfast-Lunch	4.10	6.41	7.46	7	9.13
Lunch-Dinner	3.10	4.80	5.39	6	6.08
ALERT:					
Before Breakfast	1.00	1.51	1.10	1	2.22
Breakfast-Lunch	1.93	2.51	2.47	2	3.00
Lunch-Dinner	.93	2.01	2.40	2	2.44

*NO R.T.: decimal result from predictive equation

RT: integer result using "Fractional Manpower Cutoffs for Computing Military Standards" [16]

TABLE E-5

MODEL M5 PREDICTIVE RESULTS VS OBSERVED

TEMP FOR K.P. ON WEEKDAYS
DURING SERVING PERIODS

	MIN	AVG	PREDICTED* NO R.T.	R.T.	MAX
MAIN:					
Breakfast	2.22	5.64	5.92	6	6.51
Lunch	8.54	9.53	8.16	8	10.77
Dinner	4.86	5.95	6.88	7	6.72
#649:					
Breakfast	4.00	4.90	4.05	4	5.53
Lunch	5.96	6.73	6.14	6	7.27
Dinner	3.58	5.70	5.64	6	7.88
#694:					
Breakfast	3.78	4.96	5.54	6	5.84
Lunch	6.18	7.22	7.60	8	9.42
Dinner	5.00	5.82	6.14	6	6.88
NEY HALL:					
Breakfast	13.21	15.76	15.59	15	18.63
Lunch	15.73	18.10	17.94	17	20.50
Dinner	10.33	14.20	14.20	14	16.21
ALERT:					
Breakfast	1.00	1.38	1.60	2	2.00
Lunch	1.93	2.69	3.26	4	3.38
Dinner	1.63	1.87	2.73	3	2.00

*NO R.T.: decimal result from predictive equation
RT: integer result using "Fractional Manpower Cutoffs for Computing Military Standards" [16]

TABLE E-6

MODEL M6 PREDICTIVE RESULTS VS OBSERVED

TEMP FOR KP ON WEEKENDS
DURING SERVING PERIODS

	MIN	AVG	PREDICTED* NO R.T.	PREDICTED* R.T.	MAX
MAIN:					
Breakfast	3.78	3.91	4.52	5	4.05
#649:					
Breakfast	3.07	3.38	4.13	4	3.87
Lunch	3.86	4.51	4.61	5	4.89
Dinner	4.08	4.75	4.95	5	5.83
#694:					
Breakfast	3.67	4.02	4.31	4	4.87
Lunch	4.61	4.96	5.40	6	5.47
Dinner	4.75	5.34	5.47	6	5.79
NEY HALL:					
Breakfast	12.03	13.44	12.63	12	14.30
Lunch	12.30	14.60	13.93	13	15.59
Dinner	13.88	14.98	15.19	15	15.92
ALERT:					
Breakfast	2.16	2.90	2.91	3	3.33

*NO R.T.: decimal result from predictive equation

RT: integer result using "Fractional Manpower Cutoffs for Computing Military Standards" [16]

TABLE E-7

MODEL M7 PREDICTIVE RESULTS VS OBSERVED

TEMP FOR KP ON WEEKDAYS
DURING NON-SERVING PERIODS

	MIN	AVG	PREDICTED* NO R.T.	R.T.	MAX
MAIN:					
Before Breakfast	--	--			--
Breakfast-Lunch	5.84	6.35	5.18	5	6.79
Lunch-Dinner	5.22	5.98	7.80	8	6.81
After Dinner	5.33	6.12	6.53	7	7.00
#649:					
Before Breakfast	--	--			--
Breakfast-Lunch	5.71	6.65	5.32	5	7.57
Lunch-Dinner	4.94	6.20	7.39	7	7.90
After Dinner	5.17	6.77	6.50	7	8.00
#694:					
Before Breakfast	--	--			--
Breakfast-Lunch	6.52	7.91	6.40	6	8.57
Lunch-Dinner	6.22	7.13	8.43	8	8.91
After Dinner	4.92	6.19	6.99	7	7.83
NEY HALL:					
Breakfast-Lunch	14.933	16.93	13.53	13	20.27
Lunch-Dinner	12.17	14.38	15.45	15	16.79
After Dinner	9.67	14.39	11.77	11	20.08
ALERT:					
Breakfast-Lunch	1.13	1.54	2.50	3	2.37
Lunch-Dinner	1.11	1.68	2.96	3	2.1

*NO R.T.: decimal result from predictive equation
RT: integer result using "Fractional Manpower Cutoffs for Computing Military Standards [16]

TABLE E-8

MODEL M8 PREDICTIVE RESULTS VS OBSERVED

TEMP FOR KP ON WEEKENDS
DURING NON-SERVING PERIODS

	MIN	AVG	PREDICTED* NO R.T.	R.T.	MAX
#649:					
Lunch-Dinner	3.89	4.51	4.80	5	5.44
After Dinner	4.42	5.02	5.11	5	6.00
#694:					
Lunch-Dinner	4.83	4.92	5.51	6	5.06
After Dinner	4.33	5.20	5.58	6	5.83
NEY HALL:					
Lunch-Dinner	10.72	13.29	13.19	13	16.50
After Dinner	14.11	14.78	14.33	14	15.33

MAIN: This model is not applicable since the non-serving periods are less than one-half hour in duration.

*NO R.T.: decimal result from predictive equation

RT: integer result using "Fractional Manpower Cutoffs for Computing Military Standards [16]

APPENDIX F

PRINTED OUTPUT FROM SUBPROGRAM REGRESSION:

STATISTICAL SIGNIFICANCE OF WORKLOAD FACTORS AND PREDICTIVE MODELS

The output is divided into two basic parts: (1) step-by-step results and (2) a summary table. The first part provides relevant statistical information for each regression equation calculated at each step of the forward stepwise inclusion. The summary table is printed after the final step in the analysis and provides a brief synopsis of changes occurring at each step. The complete output from the regression subprogram for Model 6 is shown in Tables F-1 and F-2. The "final step" and summary table for the other five models are shown in Tables F-3 to F-7.

Step by Step

Each step-by-step section is headed with the step number and the work load factor entered on the current step. Immediately below the heading is a statistical summary of the entire prediction equation. Statistics listed on the left side are (1) the multiple correlation coefficient (MULTIPLE R), (2) the coefficient of determination (R SQUARE), (3) the standard error of estimate for the prediction equation (STD DEVIATION), and (4) the coefficient of variability. On the right side is an ANOVA table which represents all of the information relevant to a test for R^2, the overall F test for goodness of fit of the regression equation. The calculated overall F value in step 1 of Table F-1 is 188.00627 at a level of significance better than .0005. Therefore, it would be concluded that it is highly unlikely that the sampling data was drawn from a population in which multiple R=0.

Below the foregoing information, the step-by-step output is divided into subsections labelled VARIABLES IN THE EQUATION and VARIABLES NOT IN THE EQUATION. Within the former, regression statistics are given for all work load factors entered into the predictive equation up to and including the current step. The regression coefficients are listed under the column head B. The last value in this column, labelled (CONSTANT) is the TEMP intercept. The column labelled STD ERROR B contains the standard errors for each of the regression coefficients. The F ratios and associated levels of significance shown in column labelled F are used in tests of significance for the individual B's with 1 and N-K-1 (N--the number of data points, K--number of work load factors in the predictive equation) degrees of freedom. The calculated F value shown in step 1 of Table F-1 for the constant (3.1952610) is 108.57708 at a level of significance better than .0005. Therefore, it would be concluded that it is highly unlikely the constant is equal to zero in the population.

Work load factors that have not been entered into the predictive equation are treated in the VARIABLES NOT IN segment. Under the column heading PARTIAL is the partial-correlation coefficient for each work load factor with TEMP, after work load factors already in the equation have been partialled out. The column labelled TOLERANCE indicates the proportion of the variance of that work load factor not explained by the factors already in the equation. The tolerance index has a possible range of 0 to 1. A tolerance of 0 would indicate that a given factor is a perfect linear combination of other factors. A tolerance of 1.0 would indicate that the factor is uncorrelated with the other factors. The tolerance for KPUSE in step 1 of Table F-1 (.84622) indicates that 84.622% of

the variance of this factor is unexplained by predictors (other factors) already in the equation. Under the column F significance is the F ratio for a given factor that would be obtained if that factor were brought in on the very next step. The F ratio for KPUSE is 49.341534 at a level of significance better than .0005.

Summary Table

The summary table section of the output includes information about each work load factor entered in the predictive equation. It shows the value of R and R^2 at each step in the analysis, as well as the R^2 change resulting at each successive step. The F ratio of the factor when it entered the equation and the overall F value of the factor in the final equation along with the associated levels of significance are also included.

GLOSSARY OF SYMBOLS
USED IN COMPUTER PROGRAM

SYMBOL	MEANING
HR	Hours in a work period
MEALS	Number of meals served
MFACT	Meal Factor
KPUSE	KP Utilization
HRKU	HR·KPUSE
MEHR	MEALS·HR
MFKU	MFACT·KPUSE
MFME	MFACT·MEALS
MEMEHR	MFACT·MEALS·HR
MFHRKU	MFACT·HR·KPUSE
MEHRKU	MEALS·HR·KPUSE
MFMEKU	MFACT·MEALS·KPUSE

```
FILE    NONAME    (CREATION DATE =   77/08/04.)
0* * * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * * * * * * * * * *
0DEPENDENT VARIABLE..     TEMP

PARAMETERS..  MAXIMUM STEP  10..  F TO ENTER     8.179000..  TOLERANCE      .010000..  F TO REMOVE    8.179000

MEAN RESPONSE          6.56836        STD. DEV.         3.22609

VARIABLE(S) ENTERED ON STEP NUMBER    1..     MFMEHR
```

		ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F	SIGNIFIC
MULTIPLE R	.78128						
R SQUARE	.61040	REGRESSION	1.	768.69030	768.69030	188.00627	
ADJUSTED R SQUARE	.60715	RESIDUAL	120.	490.63703	4.08864		
STD DEVIATION	2.02204	COEFF OF VARIABILITY	30.8 PCT				

VARIABLES IN THE EQUATION

VARIABLE	B	STD ERROR B	F / SIGNIFICANCE	BETA / ELASTICITY
MFMEHR	.11802723E-02	.86078770E-04	188.00627 / 0	.7812794 / .51354
(CONSTANT)	3.1952610	.30664597	108.57708 / .000	

VARIABLES NOT IN THE EQUATION

VARIABLE	PARTIAL	TOLERANCE	F / SIGNIFICANCE
KPUSE	-.54139	.84622	49.341534 / 0
MEALS	-.27266	.55812	9.5572908 / .002
MFACT	.03906	.22344	.18185696 / .671
MFKU	-.56360	.68672	55.396051 / 0
MEHR	.05674	.24314	.38436900 / .536
MEKU	-.47292	.79849	34.281142 / 0
HRKU	-.62284	.81953	75.420460 / 0
MFME	-.41294	.19136	24.463127 / .000
MFHR	.34570	.45077	16.152216 / .000
MFEHR	-.35238	.75381	16.871016 / .000
MFHRKU	-.66466	.63432	94.177315 / 0
MFMEKU	-.46558	.69637	32.934575 / 0
MEHRKU	-.51487	.77591	42.925085 / 0
MMHKP	-.51600	.66233	43.182281 / 0

TABLE F-1
COMPUTER PRINTOUT: MODEL 1--COOKS--SERVING PERIOD--WEEKDAYS

FILE NONAME (CREATION DATE = 77/08/04.)
0* M U L T I P L E R E G R E S S I O N *
0DEPENDENT VARIABLE.. TEMP

VARIABLE(S) ENTERED ON STEP NUMBER 2.. MFHRKU

MULTIPLE R	.88460	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F	SIGNIFICAN
R SQUARE	.78252	REGRESSION	2.	985.44356	492.72178	214.08312	.0
ADJUSTED R SQUARE	.77886	RESIDUAL	119.	273.88377	2.30154		
STD DEVIATION	1.51708	COEFF OF VARIABILITY	23.1 PCT				

VARIABLES IN THE EQUATION

VARIABLE	B	STD ERROR B	F / SIGNIFICANCE	BETA / ELASTICITY
MFMEHR	.16561402E-02	.81089050E-04	417.12839 0	1.0962794 .72059
MFHRKU	-.11860386	.12221533E-01	94.177315 0	-.5209062 -.17410
(CONSTANT)	2.9788182	.23114716	166.07753 0	

VARIABLES NOT IN THE EQUATION

VARIABLE	PARTIAL	TOLERANCE	F / SIGNIFICANCE
KPUSE	.14453	.17752	2.5173421 .115
MEALS	.31948	.30372	13.412797 .000
MFACT	-.21073	.20519	5.4833630 .021
MFKU	.56289	.02923	54.729402 .000
MEHR	.24134	.23514	7.2980692 .008
MEKU	.29547	.18950	11.286845 .001
HRKU	-.05863	.14133	.40704959 .525
MFME	.52420	.03979	44.711389 .000
MFHR	-.29757	.20144	11.463339 .001
MFEHR	.33176	.30840	14.593771 .000
MFMEKU	.51090	.10394	41.678331 .000
MEHRKU	.23211	.15802	6.7189667 .011
MMHKP	.46435	.06983	32.438349 .000

TABLE F-2
COMPUTER PRINTOUT: MODEL 1--COOKS--SERVING PERIOD--WEEKDAYS

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FILE NONAME (CREATION DATE = 77/08/04.)

0* M U L T I P L E R E G R E S S I O N *

0DEPENDENT VARIABLE.. TEMP

VARIABLE(S) ENTERED ON STEP NUMBER 3.. MFKU

MULTIPLE R	.92273	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F	SIGNIFICANC
R SQUARE	.85143	REGRESSION	3.	1072.22378	357.40793	225.40532	
ADJUSTED R SQUARE	.84765	RESIDUAL	118.	187.10355	1.58562		
STD DEVIATION	1.25922	COEFF OF VARIABILITY	19.2 PCT				

-------------------- VARIABLES IN THE EQUATION --------------------

VARIABLE	B	STD ERROR B	F / SIGNIFICANCE	BETA / ELASTICITY
MFMEHR	.17859257E-02	.69554628E-04	659.28732 0	1.1821908 .77706
MFHRKU	-.47453312	.49169785E-01	93.140047 .000	-2.0841417 -.69657
MFKU	.70839522	.95755839E-01	54.729402 .000	1.5354379 .44983
(CONSTANT)	3.0850156	.19239383	257.11797 .000	

---------- VARIABLES NOT IN THE EQUATION ----------

VARIABLE	PARTIAL	TOLERANCE	F / SIGNIFICANCE
KPUSE	-.16032	.13911	3.[illegible]4969 .082
MEALS	.05364	.22800	.[illegible]0929 .562
MFACT	-.07475	.19038	.65745824 .417
MEHR	.17455	.22782	3.6766688 .058
MEKU	-.16943	.09610	3.4578505 .065
HRKU	-.14029	.13989	2.3487778 .128
MFME	.01159	.00576	.15706332E-C .900
MFHR	.09507	.11988	1.0670889 .304
MPEHR	-.03171	.18766	.11778451 .732
MFMEKU	.01995	.02077	.46591984E-C .829
MEHRKU	-.17468	.09832	3.6821799 .057
MMHKP	-.01377	.02102	.22189743E-C .882

F-LEVEL OR TOLERANCE-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION.

TABLE F-3

COMPUTER PRINTOUT: MODEL 1--COOKS--SERVING PERIOD--WEEKDAYS

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CWDMP                                                                                        77/08/04.     PAGE    8

FILE    NONAME    (CREATION DATE =  77/08/04.)
0* * * * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E    R E G R E S S I O N  * * * * * * * * * * * * * * * * * * * * * *
0DEPENDENT VARIABLE..     TEMP


COEFFICIENTS AND CONFIDENCE INTERVALS.

VARIABLE           B              STD ERROR B           T              95.0 PCT CONFIDENCE INTERVAL

MFMEHR       .17859257E-02     .69554628E-04  25.676591         .16481886E-02,  .19236628E-02
MFHRKU      -.47453312         .49169785E-01 -9.6509091        -.57190268     , -.37716356
MFKU         .70839522         .95755839E-01  7.3979323         .51877259     ,  .89801785
CONSTANT     3.0850156         .19239383      16.034898         2.7040234     ,  3.4660078

VARIANCE/COVARIANCE MATRIX OF THE UNNORMALIZED REGRESSION COEFFICIENTS.

MFKU           .00917
MFHRKU        -.00461      .00242
MFMEHR         .00000     -.00000      .00000

              MFKU        MFHRKU      MFMEHR

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

CWDMP                                                                                        77/08/04.     PAGE    9

FILE    NONAME    (CREATION DATE =  77/08/04.)
0* * * * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E    R E G R E S S I O N  * * * * * * * * * * * * * * * * * * * * * *
0DEPENDENT VARIABLE..     TEMP

                                             S U M M A R Y   T A B L E

STEP      VARIABLE                 F TO        SIGNIFICANCE  MULTIPLE R  R SQUARE  R SQUARE  SIMPLE R       OVERALL F    SIGNIFICANC
     ENTERED    REMOVED       ENTER OR REMOVE                                       CHANGE

  1  MFMEHR                      188.00627          0           .78128    .61040    .61040    .78128       188.00627          0
  2  MFHRKU                       94.17732          0           .88460    .78252    .17212    .14203       214.08312       .000
  3  MFKU                         54.72940       .000           .92273    .85143    .06891    .14577       225.40532          0
```

TABLE F-4

COMPUTER PRINTOUT: MODEL 1--COOKS--SERVING PERIOD--WEEKDAYS

CWEMP 77/08/09. PAGE 9

FILE NONAME (CREATION DATE = 77/08/09.)
0* M U L T I P L E R E G R E S S I O N *
0DEPENDENT VARIABLE.. TEMP

COEFFICIENTS AND CONFIDENCE INTERVALS.

VARIABLE	B	STD ERROR B	T	95.0 PCT CONFIDENCE INTERVAL	
HR	-1.2880099	.11610318	-11.093666	-1.5232573 ,	-1.0527625
MFACT	1.3620851	.17528336	7.7707610	1.0069273 ,	1.7172430
KPUSE	-.60914927	.77476225E-01	-7.8624025	-.76613102 ,	-.45216753
MEHR	.16763302E-02	.40927636E-03	4.0958392	.84705746E-03,	.25056028E-02
CONSTANT	5.1243129	.38316147	13.373769	4.3479540 ,	5.9006718

VARIANCE/COVARIANCE MATRIX OF THE UNNORMALIZED REGRESSION COEFFICIENTS.

MFACT	.03072			
HR	-.00608	.01348		
KPUSE	-.00004	.00468	.00600	
MEHR	-.00002	-.00001	-.00003	.00000
	MFACT	HR	KPUSE	MEHR

- -

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FILE NONAME (CREATION DATE = 77/08/09.)
0* M U L T I P L E R E G R E S S I O N *
0DEPENDENT VARIABLE.. TEMP

S U M M A R Y T A B L E

STEP	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	SIGNIFICANCE	MULTIPLE R	R SQUARE	R SQUARE CHANGE	SIMPLE R	OVERALL F	SIGNIFI(
1	HR		8.54714	.006	.41959	.17606	.17606	-.41959	8.54714	.00(
2	MFACT		16.14955	.000	.64601	.41733	.24128	.36349	13.96691	.00(
3	KPUSE		41.63954	.000	.84969	.72198	.30465	-.12246	32.89383	.00(
4	MEHR		16.77590	.000	.89928	.80871	.08673	.02695	39.10639	.00(

TABLE F-5
COMPUTER PRINTOUT: MODEL 2--COOKS--SERVING PERIOD--WEEKENDS

COEFFICIENTS AND CONFIDENCE INTERVALS.

VARIABLE	B	STD ERROR B	T	95.0 PCT CONFIDENCE INTERVAL
MFKU	-.63973971	.10060455	-6.3589543	-.83896410 , -.44051532
MEALS	.13275002E-01	.12167321E-02	10.910374	.10865542E-01, .15684463E-01
MFHR	1.4274239	.10503114	13.590483	1.2194336 , 1.6354142
MEHR	-.41597806E-02	.61937451E-03	-6.7160990	-.53863107E-02, -.29332504E-02
CONSTANT	-1.1455257	.42939774	-2.6677498	-1.9958501 , -.29520128

- -

FILE NONAME (CREATION DATE = 77/08/04.)
0* M U L T I P L E R E G R E S S I O N *
0DEPENDENT VARIABLE.. TEMP

VARIANCE/COVARIANCE MATRIX OF THE UNNORMALIZED REGRESSION COEFFICIENTS.

MEALS	.00000			
MFHR	.00005	.01103		
MFKU	.00000	-.00065	.01012	
MEHR	-.00000	-.00004	-.00003	.00000
	MEALS	MFHR	MFKU	MEHR

- -

FILE NONAME (CREATION DATE = 77/08/04.)
0* M U L T I P L E R E G R E S S I O N *
0DEPENDENT VARIABLE.. TEMP

S U M M A R Y T A B L E

STEP	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	SIGNIFICANCE	MULTIPLE R	R SQUARE	R SQUARE CHANGE	SIMPLE R	OVERALL F	SIGNIFICAN
1	MFACT		94.06617	0	.66135	.43738	.43738	.66135	94.06617	0
2	MFKU		6.41138	.013	.68258	.46592	.02854	.13544	52.34219	.000
3	MEALS		18.62112	.000	.73361	.53818	.07227	.41866	46.22588	0
4	MFHR		28.25506	.000	.79209	.62740	.08922	.53487	49.67365	.000
5	MEHR		40.58163	0	.85050	.72336	.09595	.31345	61.18517	0
6		MFACT	3.65255	.058	.84541	.71472	-.00864	.66135	73.90695	.000

TABLE F-6
COMPUTER PRINTOUT: MODEL 3--COOKS--NON-SERVING PERIOD--WEEKDAYS

KPWDMP 77/08/04. PAGE 5

FILE NONAME (CREATION DATE = 77/08/04.)

0* M U L T I P L E R E G R E S S I O N *

0DEPENDENT VARIABLE.. TEMP

COEFFICIENTS AND CONFIDENCE INTERVALS.

VARIABLE	B	STD ERROR B	T	95.0 PCT CONFIDENCE INTERVAL	
MEALS	.12957184E-01	.47211775E-03	27.444815	.12022503E-01,	.13891866E-01
KPUSE	.80511466E-01	.89367406E-02	9.0090414	.62818830E-01,	.98204101E-01
CONSTANT	.37569223	.19578160	1.9189353	-.11909103E-01,	.76329355

VARIANCE/COVARIANCE MATRIX OF THE UNNORMALIZED REGRESSION COEFFICIENTS.

	MEALS	KPUSE
MEALS	.00000	
KPUSE	-.00000	.00008

- -

KPWDMP 77/08/04. PAGE 6

FILE NONAME (CREATION DATE = 77/08/04.)

0* M U L T I P L E R E G R E S S I O N *

0DEPENDENT VARIABLE.. TEMP

S U M M A R Y T A B L E

STEP	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	SIGNIFICANCE	MULTIPLE R	R SQUARE	R SQUARE CHANGE	SIMPLE R	OVERALL F	SIGNIFICAN
1	MEALS		1184.20378	0	.95216	.90660	.90660	.95216	1184.20378	0
2	KPUSE		81.16283	0	.97165	.94410	.03750	.77208	1021.73708	.000

TABLE F-7

COMPUTER PRINTOUT: MODEL 5--KP--SERVING PERIOD--WEEKDAYS

COEFFICIENTS AND CONFIDENCE INTERVALS.

VARIABLE	B	STD ERROR B	T	95.0 PCT CONFIDENCE INTERVAL
MEALS	.19511475E-01	.98873172E-03	19.733842	.17513174E-01, .21509777E-01
CONSTANT	.90898153	.38740614	2.3463271	.12600450 , 1.6919586

VARIANCE/COVARIANCE MATRIX OF THE UNNORMALIZED REGRESSION COEFFICIENTS.

MEALS	.00000
	MEALS

- -

KPWEMP 77/08/10. PAGE 5

FILE NONAME (CREATION DATE = 77/08/10.)
0* M U L T I P L E R E G R E S S I O N *
0DEPENDENT VARIABLE.. TEMP

S U M M A R Y T A B L E

STEP	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	SIGNIFICANCE	MULTIPLE R	R SQUARE	R SQUARE CHANGE	SIMPLE R	OVERALL F	SIGNIFICAN
1	MEALS		389.42452	0	.95229	.90685	.90685	.95229	389.42452	0

TABLE F-8
COMPUTER PRINTOUT: MODEL 6--KP--SERVING PERIOD--WEEKENDS

COEFFICIENTS AND CONFIDENCE INTERVALS.

VARIABLE	B	STD ERROR B	T	95.0 PCT CONFIDENCE INTERVAL
MEALS	.12788272E-01	.74019610E-03	17.276870	.11321949E-01, .14254595E-01
CONSTANT	1.6979918	.41379676	4.1034439	.87826361 , 2.5177200

VARIANCE/COVARIANCE MATRIX OF THE UNNORMALIZED REGRESSION COEFFICIENTS.

MEALS	.00000
	MEALS

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FILE NONAME (CREATION DATE = 77/08/04.)
0* M U L T I P L E R E G R E S S I O N *
DEPENDENT VARIABLE.. TEMP

S U M M A R Y T A B L E

STEP	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	SIGNIFICANCE	MULTIPLE R	R SQUARE	R SQUARE CHANGE	SIMPLE R	OVERALL F	SIGNIFICANCE
1	MEALS		298.49024	.000	.85066	.72363	.72363	.85066	298.49024	.000

TABLE F-9
COMPUTER PRINTOUT: MODEL 7--KP--NON-SERVING PERIOD--WEEKDAYS

COEFFICIENTS AND CONFIDENCE INTERVALS.

VARIABLE	B	STD ERROR B	T	95.0 PCT CONFIDENCE INTERVAL
MEALS	.17568361E-01	.10015740E-02	17.540752	.15485474E-01, .19651249E-01
CONSTANT	1.4723112	.45037916	3.2690483	.53569646 , 2.4089259

VARIANCE/COVARIANCE MATRIX OF THE UNNORMALIZED REGRESSION COEFFICIENTS.

MEALS	.00000
	MEALS

- -

FILE NONAME (CREATION DATE = 77/08/05.)
0* M U L T I P L E R E G R E S S I O N *
0DEPENDENT VARIABLE.. TEMP

S U M M A R Y T A B L E

STEP	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	SIGNIFICANCE	MULTIPLE R	R SQUARE	R SQUARE CHANGE	SIMPLE R	OVERALL F	SIGNIFICAN(
1	MEALS		307.67800	0	.96753	.93611	.93611	.96753	307.67800	0

- - - - - - - - -

TABLE F-10
COMPUTER PRINTOUT: MODEL 8--KP--NON-SERVING PERIOD--WEEKENDS

COEFFICIENTS AND CONFIDENCE INTERVALS.

VARIABLE	B	STD ERROR B	T	95.0 PCT CONFIDENCE INTERVAL
MEALS	.17568361E-01	.10015740E-02	17.540752	.15485474E-01, .19651249E-01
CONSTANT	1.4723112	.45037916	3.2690483	.53569646 , 2.4089259

VARIANCE/COVARIANCE MATRIX OF THE UNNORMALIZED REGRESSION COEFFICIENTS.

MEALS	.00000
	MEALS

- -

FILE NONAME (CREATION DATE =· 77/08/05.)
0* M U L T I P L E R E G R E S S I O N *
0DEPENDENT VARIABLE.. TEMP

S U M M A R Y T A B L E

STEP	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	SIGNIFICANCE	MULTIPLE R	R SQUARE	R SQUARE CHANGE	SIMPLE R	OVERALL F	SIGNIFICAN(
1	MEALS		307.67800	0	.96753	.93611	.93611	.96753	307.67800	0

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TABLE F-10
COMPUTER PRINTOUT: MODEL 8--KP-.-NON-SERVING PERIOD--WEEKENDS